

(1) z-parameter "open ct. parameter"

$$V_1 = Z_{11} I_1 + Z_{12} I_2$$

$$V_2 = Z_{21} I_1 + Z_{22} I_2$$



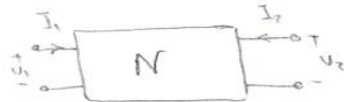
$$\begin{pmatrix} V_1 \\ V_2 \end{pmatrix} = \begin{pmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{pmatrix} \begin{pmatrix} I_1 \\ I_2 \end{pmatrix}$$

Z-Matrix

(2) Y-Parameter "short ct. parameter"

$$I_1 = Y_{11} V_1 + Y_{12} V_2$$

$$I_2 = Y_{21} V_1 + Y_{22} V_2$$



$$\begin{pmatrix} I_1 \\ I_2 \end{pmatrix} = \begin{pmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{pmatrix} \begin{pmatrix} V_1 \\ V_2 \end{pmatrix}$$

Y-Matrix

(3) Hybrid parameter

$$V_1 = h_{11} I_1 + h_{12} V_2$$

$$I_2 = h_{21} I_1 + h_{22} V_2$$

$$\begin{pmatrix} V_1 \\ I_2 \end{pmatrix} = \begin{pmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{pmatrix} \begin{pmatrix} I_1 \\ V_2 \end{pmatrix}$$

(4) Transmission parameter.

$$V_1 = A V_2 - B I_2$$

$$I_1 = C V_2 - D I_2$$

$$\begin{pmatrix} V_1 \\ I_1 \end{pmatrix} = \begin{pmatrix} A & B \\ C & D \end{pmatrix} \begin{pmatrix} V_2 \\ I_2 \end{pmatrix}$$

* if $Z_{12} = Z_{21}$ or $Y_{12} = Y_{21}$
 ∴ Reciprocal system

* if $Z_{11} = Z_{22}$ or $Y_{11} = Y_{22}$
 ∴ symmetrical system

* Z-parameter → T-Model
 Y-parameter → π-Model

T-Model & π-Model
 . from (T → π)

$$Z_A = \frac{Z_1 Z_2 + Z_1 Z_3 + Z_2 Z_3}{Z_2}$$

مثل 2 مع بعضه
البقية كلها

$$Z_B = \frac{Z_1 Z_2 + Z_1 Z_3 + Z_2 Z_3}{Z_1}$$

$$Z_C = \frac{Z_1 Z_2 + Z_1 Z_3 + Z_2 Z_3}{Z_3}$$

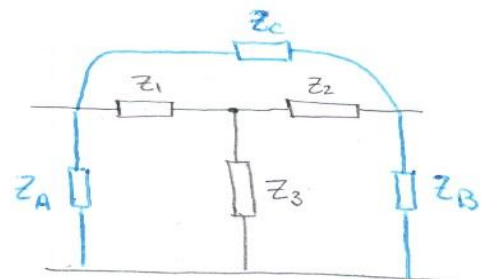
. from (π → T)

$$Z_1 = \frac{Z_A Z_C}{Z_A + Z_B + Z_C}$$

ال 2 الى ال 3
كلهم مع بعضه

$$Z_2 = \frac{Z_B Z_C}{Z_A + Z_B + Z_C}$$

$$Z_3 = \frac{Z_A Z_B}{Z_A + Z_B + Z_C}$$



→ Relationship among two port parameter.

II $Z \rightarrow Y$

$$[Y] = [Z]^{-1} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix}^{-1} = \begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix}$$

② $Y \rightarrow Z$
 $[Z] = [Y]^{-1}$

③ $T \rightarrow Z$

$$Z_{11} = \frac{A}{C}$$

$$Z_{12} = \frac{AD}{C} - B$$

$$Z_{21} = \frac{1}{C}$$

$$Z_{22} = \frac{D}{C}$$

③ $Z \rightarrow T$

$$C = \frac{1}{Z_{21}}$$

$$D = \frac{Z_{22}}{Z_{21}}$$

$$A = \frac{Z_{11}}{Z_{21}}$$

$$B = \frac{Z_{11}Z_{22}}{Z_{21}} - Z_{12}$$

* check for Hurwitz.

IF $P(s) = s^3 + 2s^2 + 3s + 6$ "Polynomial"

Sols

even part

$$m(s) = 2s^2 + 6$$

odd part

$$n(s) = s^3 + 3s$$

أقسام ال order الأكبر

على ال order الأصغر

ولا يتم بطرح ال 3 poles

على ال من degree 3

$$\text{Ex: } s^7 + 2s^6 + 2s^5 + s^4 + 4s^3 + 8s^2 + 8s + 4$$

Sols-

$$m(s) = 2s^6 + s^4 + 8s^2 + 4$$

$$n(s) = s^7 + 2s^5 + 4s^3 + 8s$$

Note:-

لوفال Hurwitz check

$$P(s) = \frac{s^2 + 2s + 1}{s^3 + 2s^2 + 2s + 40}$$

Sols-

$$\therefore P(s) = N(s) + D(s) = s^3 + 3s^2 + 4s + 41$$

not Hurwitz من غير اختيار

$$\begin{array}{r} 2s^6 + s^4 + 8s^2 + 4 \overline{) s^7 + 2s^5 + 4s^3 + 8s} \\ q_1 \leftarrow \boxed{1/2 s} \quad s^7 + 1/2 s^5 + 4s^3 + 2s \\ \hline 3/2 s^5 + 6s \overline{) 2s^6 + s^4 + 8s^2 + 4} \\ q_2 \leftarrow \boxed{4/3 s} \quad 2s^6 + 8s^2 \\ \hline s^4 + 4 \overline{) 3/2 s^5 + 6s} \\ q_3 \leftarrow \boxed{3/2 s} \quad 3/2 s^5 + 6s \\ \hline 0 \end{array}$$

all are +ve

There is only 3 quotient only

∴ There is common factor

$$s^3 + 2s^2 + 2s + 1$$

$$\begin{array}{r} s^4 + 4 \overline{) s^7 + 2s^6 + 2s^5 + s^4 + 4s^3 + 8s^2 + 8s + 4} \\ s^7 \quad \quad \quad + 4s^3 \\ \hline 2s^6 + 2s^5 + s^4 + 8s^2 + 8s + 4 \\ - 2s^6 \quad \quad \quad + 8s^2 \\ \hline 2s^5 + s^4 + 8s + 4 \\ - 2s^5 \quad \quad \quad - 8s \\ \hline s^4 + 4 \\ - s^4 - 4 \\ \hline 0 \end{array}$$

بقسم على اضربا فنتي على فوف

و يقسم قسمة مطولة عادي

طالما زي ثلاثة و ما نه

$$(s^4 + 4)(s^3 + 2s^2 + 2s + 1) = 0$$

$$s^4 = -4$$

$$s^2 = \pm j2$$

$$s = \pm \sqrt{j2} \quad \pm \sqrt{-j2}$$

صياغة لها عند ال j
بردة

∴ There is a multi poles at j axis
∴ not Hurwitz.

لأننا لو كانت كل ال poles بار -ve يعني ال LHS

ليس Hurwitz

Test the following fun. whether they are PRF or not giving reasons.
given: $P(s) = \frac{N(s)}{D(s)}$

condition to be PRF

- $m_1, m_2 - n_1, n_2 \geq 0 \forall \omega$
- all poles lie in LAP
- All coeff are real & +ve

exs $P(s) = \frac{2s^3 + 3s^2 + 3s + 3}{s^2 + 1}$

sol: Hurwitz check في الأول حل

$$m_1 = 3s^2 + 3 \quad n_1 = 2s^3 + 3s$$

$$m_2 = s^2 + 1 \quad n_2 = 0$$

$$m_1, m_2 - n_1, n_2 = (3s^2 + 3)(s^2 + 1) - 0$$

$$= 3s^4 + 6s^2 + 3 \quad | \quad s$$

$$= 3(j\omega)^4 - 6(j\omega)^2 + 3$$

$$= 3\omega^4 + 6\omega + 3 \geq 0 \forall \omega$$

Zero في دالة ω ومرة في دالة ω

$\therefore P(s)$ is PRF:

check PRF لازم اعمل check for Hurwitz قبل ما اعمل

$$P(s) = \frac{2s^3 + 3s^2 + 3s + 3}{s^2 + 1}$$

$$= 3s^3 + 4s^2 + 3s + 4$$

$$m(s) = 4s^2 + 4$$

$$n(s) = 3s^3 + 3s$$

واقسم الكبير على الصغير

$$4s^2 + 4 \overline{) 3s^3 + 3s}$$

$$\left(\frac{3}{4}s \right) \quad 3s^3 + 3s$$

0

$$4s^2 + 4 \overline{) 3s^2 + 4s^2 + 3s + 4}$$

$$3s^2 + \quad 3s$$

$$4s^2 + 4$$

$$4s^2 + 1$$

0

$$\therefore (4s^2 + 4)(\frac{3}{4}s + 1) = 0$$

$$s = \pm j \quad s = -4/3$$

LHS

$\therefore$ Herwit.

m_1 & m_2 : even part in $N(s)$ & $D(s)$

n_1 & n_2 : odd part in $N(s)$ & $D(s)$.

Note

قبل ما اعمل لازم اتأكد انه مفيد

خو بين صفرين في بعض وزي بعض

فوقه او تحت بعض مثلاً لو اداني

$$P(s) = \frac{s(s+5)}{s^4 + 2s^2 + 1}$$

الجزء ده ممكن يغير

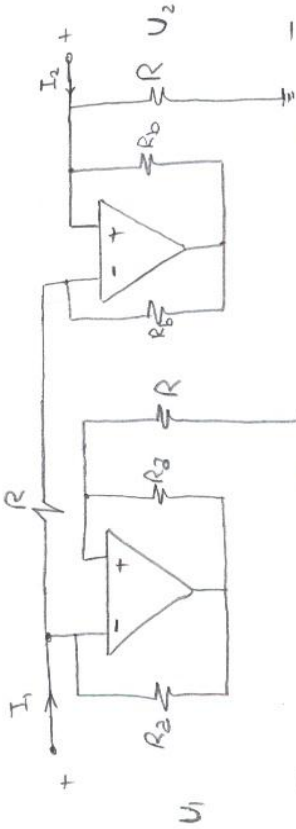
بين متكرر $(s^2 + 1)(s^2 + 1)$

$\therefore$ not PRF because has a multiples

$$(s^2 + 1)(s^2 + 1) = (s^2 + 1)^2$$

Network Realization

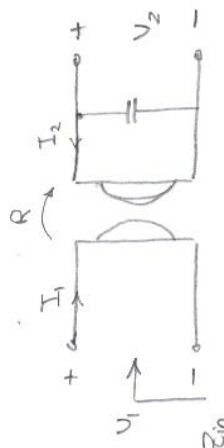
Deboo



$\equiv$ Gyrator $(20\text{pamp} + 7R)$

Grounded inductor

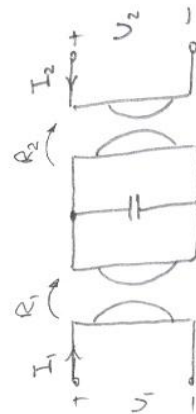
Floating inductor



$$L = R^2 C$$

10 element

$$(20\text{pamp} + 7R + 1C)$$

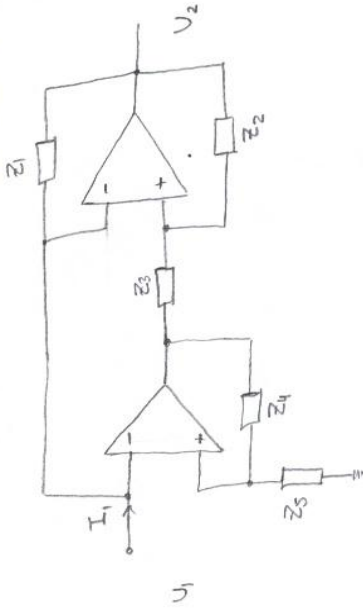


$$L = R^2 C$$

14 element

$$(40\text{pamp} + 14R + 1C)$$

Riorden



$$Z_{in} = \frac{V_1}{I_1} = \frac{Z_1 Z_3 Z_5}{Z_2 Z_4}$$

$\frac{1}{s}$ FDNR

$(20\text{pamp} + 3R + 2C)$

$$Z_1 = Z_3 = Z_5 = R$$

$$Z_2 = Z_4 = 1/sC$$

$$\omega \rightarrow Z_{in} = -\omega^2 C R^3$$

Grounded

inductor

$(20\text{pamp} + 3R + 2C)$

$$Z_1 = Z_2 = Z_3 = Z_5 = R$$

$$Z_4 = 1/sC$$

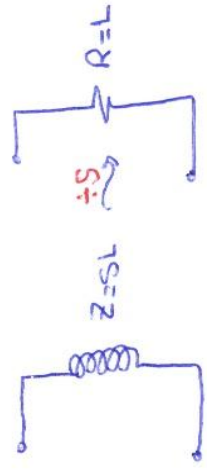
$$\omega \rightarrow Z_{in} = R^2 sC$$

$$\omega \rightarrow L = R^2 C$$

Floating induct. $\{$ Sheet 4 $\}$

$(20\text{pamp} + 7R + 2C)$

Bruton transformation



$$Z = sL$$

$$R = L$$



$$R/s$$

$$\omega \rightarrow C = 1/R$$



FDNR

$$Z_c = 1/s^2 C$$

$$Z_{in} = 1/\omega^2 C$$

Realization of one port Network using LC

Foster I

Foster II

Cauer I

Cauer II

→ Foster (I) It deals with $Z(s)$

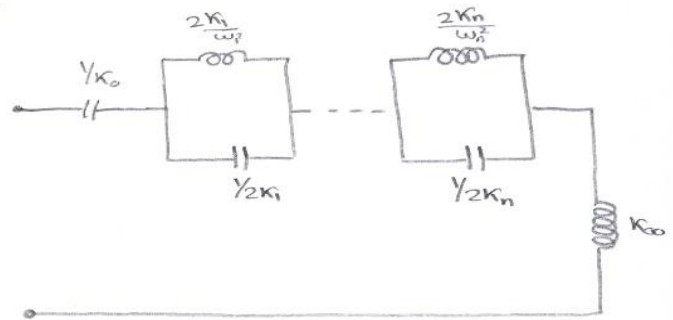
- $| \text{Degree of } N(s) - \text{Degree of } D(s) | \geq 1$
- It provides series Network
- $Z(s) = \frac{\text{odd}}{\text{even}}$ or $\frac{\text{even}}{\text{odd}}$

$$\therefore Z(s) = \frac{K_0}{s} + \sum_{n=1}^N \frac{2K_n s}{s^2 + \omega_n^2} + K_{\infty} s$$

$$K_0 = \lim_{s \rightarrow 0} s Z(s)$$

$$K_{\infty} = \lim_{s \rightarrow \infty} \frac{Z(s)}{s}$$

$$2K_n = \lim_{s \rightarrow -j\omega_n} (s^2 + \omega_n^2) \frac{Z(s)}{s}$$



→ Foster (II) It deals with $Y(s)$

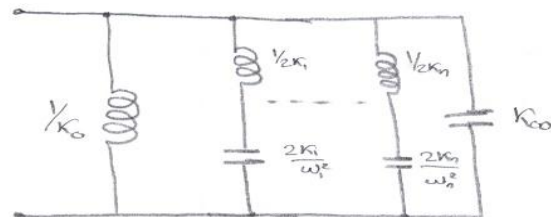
- $| \text{Degree of } N(s) - \text{Degree of } D(s) | \geq 1$
- It provides series Network
- $Y(s) = \frac{\text{even}}{\text{odd}}$ or $\frac{\text{odd}}{\text{even}}$

$$\therefore Y(s) = \frac{K_0}{s} + \sum_{n=1}^N \frac{2K_n s}{s^2 + \omega_n^2} + K_{\infty} s$$

$$K_0 = \lim_{s \rightarrow 0} s Y(s)$$

$$K_{\infty} = \lim_{s \rightarrow \infty} \frac{Y(s)}{s}$$

$$2K_n = \lim_{s \rightarrow -j\omega_n} (s^2 + \omega_n^2) \frac{Y(s)}{s}$$



Cauer (I)

1. It deals with both $Z(s)$ & $Y(s)$

IF Given $Z(s)$

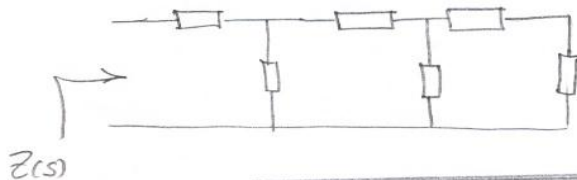
$$1 - \lim_{s \rightarrow \infty} Z(s) = \infty$$

IF given $Y(s)$

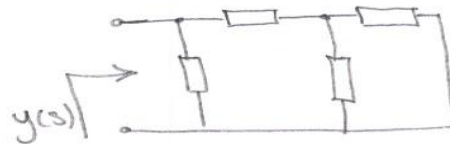
$$1 - \lim_{s \rightarrow \infty} Y(s) = \infty$$

2. write both $N(s)$ and $D(s)$ in descending order
3. Apply continued fraction expansion

4. Draw the resulting network in Ladder form starting with Series element.



5. Draw the resulting network in ladder form start with parallel element.



Cauer (II)

1. It deals with both $Z(s)$ & $Y(s)$

1- $Z(s)$

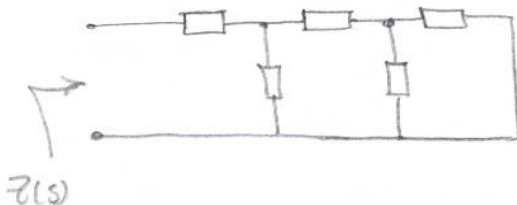
$$\lim_{s \rightarrow 0} Z(s) = \infty$$

$Y(s)$

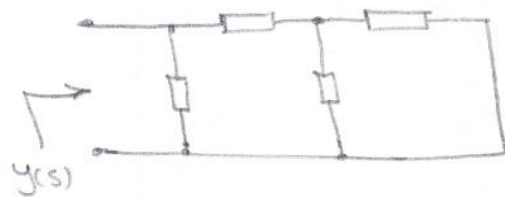
$$\lim_{s \rightarrow 0} Y(s) = \infty$$

2. write both $N(s)$ and $D(s)$ in ascending order
3. Apply continued fraction expansion

4. Draw the resulting Network in ladder form start with Series element



4. Draw the resulting network in ladder form start with parallel element.



Realization of one port Network using RC and RL

RC : $Z(s) = \frac{N(s)}{D(s)}$ or $y(s) = \frac{N(s)}{D(s)}$

$$\frac{N(s)}{D(s)} = \frac{\text{odd} + \text{even}}{\text{odd} + \text{even}} \begin{cases} \text{RC} \\ \text{RL} \end{cases}$$

$$\begin{aligned} Z(0) &\geq Z(\infty) \\ y(0) &\leq y(\infty) \end{aligned} \quad \rightarrow \text{RC}$$

RL :

$$Z(s) = \frac{N(s)}{D(s)} \quad \text{or} \quad y(s) = \frac{N(s)}{D(s)}$$

$$\frac{N(s)}{D(s)} = \frac{\text{odd} + \text{even}}{\text{odd} + \text{even}}$$

$$\begin{aligned} Z(0) &\leq Z(\infty) \\ y(0) &\geq y(\infty) \end{aligned} \quad \rightarrow \text{RL}$$

cover I & II

المسألة الأولى

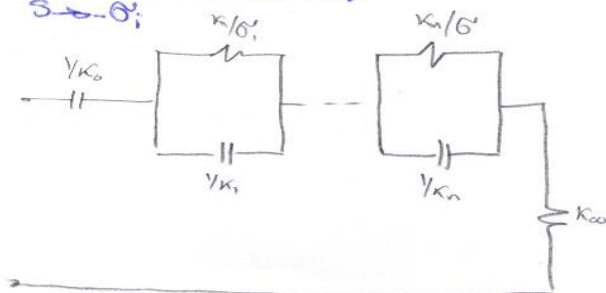
Foster (I)

$$Z(s) = \frac{K_0}{s} + \sum_{i=1}^n \frac{K_i}{s + \sigma_i} + K_{\infty}$$

$$K_0 = \lim_{s \rightarrow 0} sZ(s)$$

$$K_{\infty} = \lim_{s \rightarrow \infty} Z(s)$$

$$K_i = \lim_{s \rightarrow -\sigma_i} (s + \sigma_i) Z(s)$$



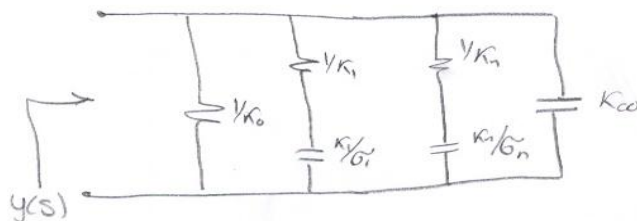
Foster (II)

$$y(s) = \frac{K_0}{s} + \sum_{i=1}^n \frac{K_i}{s + \sigma_i} + K_{\infty}$$

$$K_0 = \lim_{s \rightarrow 0} sy(s)$$

$$K_{\infty} = \lim_{s \rightarrow \infty} y(s)$$

$$K_i = \lim_{s \rightarrow -\sigma_i} (s + \sigma_i) y(s)$$



-9-